

## Loss of Soil and Water in Loess Plateau of Yellow River Basin and Its Preventive Countermeasure

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**Abstract:** The loess plateau of Yellow River valley (called loess plateau for short as follows) extends from Riyue Mountain in the west to Taihang Mountains in the east, and from Qinling Mountains in the south to Yinshan Mountains along the northern edge of the plateau. It includes 46 regions (city, prefecture and league) in 7 provinces and 306 counties (town, region and flag), with the total area of land 640,000km<sup>2</sup>. The total population is 90.75 million, among which there is 69.2 million of agricultural population.

### 1 Survey on loss of soil-water in loess plateau and its law of sediment yield and transport

#### 1.1 Survey on loss of soil and water

The regions of mountains, rolling and the top of plateau in loess plateau account for 2/3 of the total area of land, a big part is covered by loess, its thickness is 100m—200m commonly and texture is porous with poor erosion resistance. There are more than 270,000 gullies above 0.5km, with dissected landform, criss-crossing gullies, steep slope and deep gully. The vegetation is sparse, the natural secondary forest and natural grassland in the whole region only account for 16.6%, the rest part of the region is bare hills and mountains with little rainfall and rainstorm concentrated, the annual precipitation in the most regions is 200mm—400mm with rainstorm occurred. The precipitation from June to September accounts for 60%—70% of the whole year's. Under this special natural conditions and long-term effect by manmade factors, this region has become one with the most serious loss of soil and water and the weakest ecological environment in our country and in the world. The obvious characteristics are shown below:

(1) Large area of loss of soil and water. There is loss of soil and water almost everywhere in loess plateau in which 454,000km<sup>2</sup> of the area above 1,000t/(km<sup>2</sup> • a) of erosion modulus account for 70.9% of the total area of land.

(2) Strong erosion intensity. The area of water erosion with strongest intensity above 1,000t/(km<sup>2</sup> • a) of erosion modulus is 85,400km<sup>2</sup> accounting for 64.4% of same area in the whole country. The area of serious water erosion above 15,000t/(km<sup>2</sup> • a) of erosion modulus is 36,700km<sup>2</sup> accounting for 89% of the same area in the whole country.

(3) Large Quantity of sediment losing. The mean amount of sediment transport for years is 1.6 billion t in the Yellow River, its mean concentration is 35kg/m<sup>3</sup>, with the first grade of rivers in the world.

(4) Large harm of loss of soil and water. First, the poverty is aggravated, the poor population accounts for 1/3 of the whole country. Second, the river-bed is raised by sediment deposition, the reservoir is deposited and flood harm is aggravated; Third, the sustainable development of national economy is restricted, the human vivosphere is harmed; forth, the exploitive utilization of water resources in the Yellow River has been affected.

(5) Big difficulty of harnessing. The types of loss of soil and water in loess plateau are varied, the forming reason is complex, water erosion, wind erosion and gravitational erosion are blended each other with big difficulty of harnessing.

As mentioned above, the loss of soil and water is a prime problem of environment both in Yellow River valley and in our country. To prevent loss of soil and water quickly has become an urgent strategic task faced with people of the whole country, a matter of fundamental importance to strive existing development for the Chinese nation and is a great struggle to protect the vivosphere of the Chinese nation.

## 1.2 Law of sediment yield and transport

(1) The regions of sediment yield in the Yellow River are mainly in the loess plateau. The sediment deposition is mainly concentrated in the lower reaches. There is 1/4 of sediment transported into the Yellow River every year deposited in the lower channel, the median diameter above 0.05mm of coarse sediment accounts for majority of deposited sediment. The research shows that coarse sediment deposition plays a leading role in changes of the lower. Therefore, to tighten up harnessing the source region with amounts of sediment and coarse sand and reduce sediment into Yellow River (especially coarse sediment) is of great strategic significance in Yellow River's harnessing and development.

(2) The area of regions with amounts of sediment and coarse sand is 78,600km<sup>2</sup>, which distributed between Hekouzhen and Longmen, and the upper reaches of Jinghe, Weihe and Luohe.

(3) The area of regions with amounts of sediment and coarse sand accounts for 10.4% of the whole basin's, but amounts of sediment transport accounts for 65.2% of the total in Yellow River, the coarse sediment yield accounts for 73% of the total. Therefore, to tighten up controlling loss of soil and water in the region is the key to reduce sediment deposition in the lower Yellow River.

(4) 70% of sediment in the loess plateau is from land along gullies, 30% is from land between gullies; but sediment from land between gullies must be transported by land along gullies, therefore the gully engineering is a key measure to retain sediment.

## 2 Developing situation of economy, society in loess plateau and its status quo of conservation of soil and water

### 2.1 Situation between economy and society

The land area per a person on average in loess plateau is 0.92 hm<sup>2</sup>, the annual sunshine time is about 3,000h, suitable to above thousand plants growing such as grass, shrub and arbor etc. Because of population increasing rapidly, pressure of grain problem forced, deforestation and reclamation of land wantonly, stripping of grass for planting crops, extensive cultivation and small harvest, and overgrazing and plundering management, these lead to vegetation exhausted and form two vicious circles of "the poorer the more reclaiming, the more reclaiming the poorer", "the more grazing the more waste, the more waste the more grazing". With the development of economy and society, the resource development and force degree of basic construction enlarge day by day, the pressure caused to ecology and environment is getting larger and larger. The results are shown below:

(1) The natural disasters of drought etc are intensified by ecological weakness and environment worsening

According to the data during the past 44 years in 18 drought counties in Gansu province, there are 17 years of drought or serious drought, accounting for 38.6%. There are 19 years of the other disasters such as wind, hail and frost etc, accounting for 43.2%.

(2) The irrational land utilization and industrial structure. Based on the statistics of ecological construction project areas on conservation of soil and water in the Yellow River, the proportion of agriculture, forest and grazing land is 6.4:3.6:1. The output values of farming, forestry, stock raising, fishery, sidelines and the others account for 47.02%, 8.06%, 25.4%, 25.4%, 12.12%, 0.86% and 6.54% in succession. And single product economy is to take grains as a principle thing.

(3) Low productivity of land. The per unit area yield of slope land accounted for over 60% of cultivated area is only 750kg/ hm<sup>2</sup>, the hay quantity in unit area of pasture is only 4.05t/ hm<sup>2</sup>.

(4) Living difficulty of peasants. The grain yield per a person on average in loess plateau was 350kg in 2,000, the income per a person was 1,019yuan, in less than 1/2 of income per a person from countryside in the whole country.

(5) The loss of soil and water manmade increases day by day, the situation of "harnessing and destroying at the same time" has not been thoroughly transformed yet.

## **2.2 Status quo of conservation of soil and water**

There is a conservation of soil and water from ancient time for a production practice. To carry out the conservation of soil and water by big margin began in 1950s. Through practicing and exploring step by step, an approach is summarized until 1990s that the various harnessing measures are rationally disposed, the biological measures should go hand in hand with engineering and farming measures, harnessing slopes should be well coordinated with harnessing gullies, the preventing protection should be implemented together with harnessing and development, and ecological benefits should be linked with economic and social benefits with tributaries as framework and small watersheds as units.

Since a half century, the area of comprehensive harnessing carried out is over 180,000km<sup>2</sup>, in which building terrace is more than 5,000,000 hm<sup>2</sup>. There are more than 3,000,000 small-scale projects of conservation of soil and water and above 100,000 silt-trap dams. The cropland with high and stable yield of gully-dams deposited and small catchment-tableland built is over 1,400,000 hm<sup>2</sup>, plantation and growing grass are 11,450,000 hm<sup>2</sup>. The comprehensive benefits are up to more than 2,000yuan, the production and living environment has been improved and the problems out of poverty of more than 10,000,000 peasants have been solved. The mean amounts of sediment into the Yellow River for years decrease 0.3 billion t, the contribution has been made for the Yellow River's safety.

According to natural and social economy situation in loess plateau, we should construct agriculture with intensive and self-sufficiency, forestry with ecological benefits and animal husbandry with commodity-acquire wealth, realize the goal of beautiful environment, production development and peasants becoming rich.

## **3 Preventive countermeasure on loss of soil and water**

The preventive countermeasures on loss of soil and water in loess plateau are: to grasp "two key points"(harnessing regions with amounts sediment and coarse sediment and constructing gullies harnessing project) and realize "two goals"(improving production conditions and ecological environment and harnessing the Yellow River) in light of law of sediment yield and transport in loess plateau and demands of social economic development and in line with principle of "suiting measures to local conditions, setting up defenses because of harms and acting according to law of nature and economy". Realizing industrial structure's regulation, resources of soil and water with economic protection, rational development and optimum disposition, and constructing ecological barrier in loess plateau provide the support and defense for the Yellow River's harnessing and development, sustainable development of watershed's economy and society and smooth implement of big development in the west.

In light of demands of grasping "two key points" and realizing "two goals", "a policy and four methods" are taken.

### **3.1 A policy**

Retaining sediment by storage, thoroughgoing reform and developmental production. That is, to take measures for the whole control of gullies, slope surface harnessing with scientific conveyance system and vegetation construction, to make sediment retained in criss-crossing gullies and wide land, to deposit flat land and fertile soil, to develop basic cropland, forage base and base of multiple management, to vacate slope land of hills for growing trees and grass, to prohibit grazing and close hillsides to facilitate plantation, and expand vegetation construction. To retain and store natural rainfall, to raise degree of natural runoff resources and capacity of water resources environment, to provide water source for ecological construction and conserve water and soil, and regulate natural climate in loess plateau step by step, to improve ecological environment fundamentally and realize sustained and stable aims to reduce sediment into the Yellow River and develop production.

### **3.2 Four methods**

(1) Constructing dam system of backbone projects combined with silt-trap dam in gullies. Their

roles are: to raise erosive datum, to control gully bottom cutting, gully bank expanding and gully head advance; to trap sediment for reducing sediment into the Yellow River; to deposit land for constructing basic cropland with high and stable yield; to store water for breeding and watering land and solving domestic water; to promote land utilization and industrial structure regulation; to improve traffic conditions using dam instead of road. Until 2050, 21,000 backbone projects for controlling gullies plan to be constructed in loess plateau (including constructed projects), 242,000 silt-trap dams will be built for depositing land of 930,000hm<sup>2</sup> and retaining sediment of more than 40 billion t.

(2) The slope-land of mountains will be harnessed comprehensively with measures of agriculture, forestry, animal husbandry and water linked with together to realize ecological stability and sustainable development of economy. First, constructing basic cropland, spreading practical techniques of dry crops agriculture, developing intensive and high-effective planting, setting up grain production base, and returning land cultivated and forest and grass, and regulate industrial structure. There are 6,460,000hm<sup>2</sup> of existing basic cropland and 8,230,000 hm<sup>2</sup> of cultivated land on slope in loess plateau. Until 2010, 2,570,000 hm<sup>2</sup> of basic cropland will be reconstructed, up to 9,030,000 hm<sup>2</sup> in total, attaining basic cropland of 0.13 hm<sup>2</sup> everybody on average and self-efficiency in grains. Second, starting from grass, grass and shrub going ahead, combining grass with shrub and arbor, and enlarging force degree of vegetation construction. Planting and growing grass in all barren mountain, waste slope land, waste gullies and sediment except land behind silt-trap dams; returning cultivated land, forest and grass all for original cultivated land of slope except slope being changed into terrace planned. Up to 2,050, the total task of vegetation construction is 36,400,000 hm<sup>2</sup>, in which planting forests of conservation of soil and water are 22,080,000 hm<sup>2</sup>, economic forests 4,000,000 hm<sup>2</sup>, grass grown by people 10,320,000 hm<sup>2</sup>, vegetation is up to 56.9%.

(3) Building silt-trap reservoir in tributaries with coarse sediment concentrated and implementing water and sediment regulation in parts of an area. Huangfuchuan, Gushanchuan, Kuyehe and Tuweihe are the most concentrated tributaries with coarse sediment in the Yellow River, and joined together. The area in the region is 16,518km<sup>2</sup>, annual runoff is 1.408 billion m<sup>3</sup>, the coarse sediment is about 0.134 billion t accounting for 42% of incoming coarse sediment in regions with amounts of sediment and coarse sand. The modules of sediment transport are 13,780t/(km<sup>2</sup> • a), to build silt-trap works concentrated in these four tributaries is of important significance in reducing sediment of the Yellow River and lightening deposition in the lower Yellow River. It is roughly estimated that 4 silt-trap reservoirs with 70m—90m of dam height can be constructed in main stream of four rivers; 33 silt-trap reservoirs with 80m—100m of dam height are constructed in 28 lateral ditches, the area of controlling watersheds is 3,395 km<sup>2</sup>, accounting for 20% of total area in four rivers. The capacity contained in silt-trap works in four rivers is 10 billion m<sup>3</sup>, providing water source of 8—10 billion m<sup>3</sup> for the local every year, reducing sediment of 0.2 billion t into the Yellow River each year, with 60% of coarse sediment harmed seriously, the benefits of flood control and deposition reduction on the lower Yellow River are very notable; the silt-trap reservoirs in main stream and tributaries can deposit land of 22,000 hm<sup>2</sup>, the useful area is 13,200 hm<sup>2</sup>; the stored water and deposited land in silt-trap reservoirs of main stream and tributaries will exert a huge influence on the local ecological environment.

(4) We should rely on itself renovated ability in nature, close hillsides to facilitate plantation and grass, expand vegetation cover, quicken harnessing speed and improve ecological environment while harnessing artificially. It is proved from practice that it can be implemented in regions with 200mm precipitation above as long as the closure and prohibited protection is carried out, the vegetation can be recovered in a few years. In Wuqi county in Shanxi province, the barren mountains of 134,000 hm<sup>2</sup> was all closed and prohibited, raising in sheds instead of grazing, the vegetation recovered by itself ability of nature except plantation and growing grass of 103,000 hm<sup>2</sup> on cultivated land returned from winter in 1998 to spring in 2001. Under conditions of drought for 3 years running, the barren mountains in the whole county were changed into green, and were 2.7 times as much as stored area with plantation and growing grass before 1997.

In a world, the implement of “a policy and four methods” will make people who live in loess plateau become rich, mountains green, sediment reduce into Yellow River, people and nature develop

harmoniously and the aims of mountain beauty realized.

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